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Environmental and Social Sustainability in UK Construction Industry: a Systematic Literature Review

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Abstract

Research on sustainability in the construction industry is common in construction journals addressing the potential adverse effects conventional practices have in the construction community. Sustainability is addressed through the environmental, social and economic impacts in literature and researchers and practitioners always drive the need for an equal attention on these three dimensions, but not so successfully at present. Sustainability covers a broad content with various suggested approaches arising from different countries all over the world. Previous studies have investigated sustainable construction issues as a global concept and in individual developed countries such as the US, Australia, and China. The aim of this research is to investigate the extent of coverage, by academia, of the sustainability concept in UK construction industry, with a focus on the environmental and social aspects of sustainability, based on the Triple Bottom Line framework. The researchers conducted a systematic literature review, searching relevant articles with predefined criteria in two major bibliographical databases, which offer great coverage of the existing academic journals in social sciences. The study utilised the PRISMA reporting approach and the search resulted in thirty-one suitable articles. The findings revealed that environmental sustainability receives much more attention than social sustainability. Added emphasis is given to green buildings and materials used. Government regulations seem to be the leading driver for adopting sustainable practices, while lack of knowledge/awareness of sustainable best practices is the leading challenge.

Keywords: environmental sustainability, social sustainability, UK construction industry, systematic literature review, Triple Bottom Line.

Introduction

The sustainability issue in the construction industry have long been debated among scholars, researches, and practitioners alike since the early 1990s. The design, building and maintenance of the built environment, infrastructure works such as roads, railways and bridges are all carried out by the construction industry (Bosher et al., 2007). Operations in the UK construction industry involves several disciplines, including but not limited to architecture, engineering, consultants, builders, and surveyors, thus, Bosher et al. (2007) and Opoku & Ahmed (2014) exclaimed weaknesses in the UK construction industry through fragmentation of construction professional roles, which further hindered because some professionals are self-employed or sub-contractors. Activities within the UK construction industry were reported to account for up to 50% of energy consumption, and more than 50% of all carbon emissions can be accredited to usage of energy in buildings (Petri et al., 2015), consumption of land space (Opoku & Ahmed, 2013), consumption of 12-16% of water available, and 32% of renewable and unrenewable resources (Darko et al., 2017), and creation of up to 19% of total UK waste materials (Wang et al., 2014). Therefore, the UK construction industry is under pressure to change its current conventional practice and its sustainable practice.

Sustainable construction in practice involves various aspects, including engineering, planning, regulations, supply chain, procurement, innovation, skills, economics, market effects and many more (Ravetz, 2008). Through this, the opportunity to mitigate environmental, social and economic damages arises. Therefore, as reported by Alkhaddar et al. (2012), Khalfan (2006), Durdyyev et al. (2018), Renukappa et al. (2012), Opoku and Ahmed (2013), sustainable construction pursues a balance of the environmental resources, social development, and an economic growth in the UK construction industry for current and future generations to come.

Numerous actions to deliver a sustainable development in UK construction industry includes tracking and minimising energy consumptions (Gottsche et al., 2016), reuse and recycling of construction materials (Essex & Whelan, 2010), sustainable procurement and the use of sustainable building material (Brooks & Rich, 2016; Wang et al., 2014), as well as integration of lean practice into construction activities (Ogunbiyi et al., 2014).

The drivers and potential drawbacks to sustainability practices in the UK construction industry have been reported in previous studies, concomitantly identifying (institutional) theories as a facilitator and hinderance of sustainable construction. The aim of this research is to investigate the extent to which existing literature covers the sustainability issues in the UK construction industry. To accomplish this aim, a systematic review has been conducted, searching within two major bibliographic databases and returning thirty-one relevant articles in total.

Theoretical background

The chatters surrounding the topic of sustainability have been reported in a large number of literature articles (Edum-Fotwe & Price 2009) spanning back to the last two decades and have been captured by a global audience as reported by Hay et al. (2014) and Lindsey (2011).

There is no universal definition for sustainability nor there is a specific optimal process of criteria for assessing it (Voinov, 2006; Hacking & Guthrie, 2008; Bond & Morrison-Saunders, 2011). Sustainability can be interpreted as to sustain, maintain, or continue (Hay et al., 2014). It can also be interpreted as a process of change (Kim and Oki, 2011; Hay et al., 2014), a state of equilibrium (Heal 2012; Hay et al., 2014), a property of an entity (Wahl and Baxter 2008; Hay et al., 2014).

2.1 Sustainability framework – the triple bottom line perspective

Defining sustainability concepts and achieving sustainability through actions and performances separate entities on which governments, organisation and institution worldwide are working towards. As reported above, the increasing popularity among scholars and researchers on current and future tools, methods, and assessment criteria for measuring sustainability is under continuous study (Norman and MacDonald, 2004; Slaper and Hall, 2011).

The triple bottom line (TBL) paradigm is the most reported and cited framework or method for addressing organisation's sustainability activities and it encompasses the social, environmental and economic dimensions, which seek equal balance (Little, 2014). It emerged during the mid-1990s and was developed by John Elkington, who sought out a method for assessing the performance of organisations in corporate America (Elkington, 1994). Slaper and Hall (2011) reported the TBL tool that a concept that operates beyond the traditional measurement of profit and returns on investments, to include an environmental and social impact measurement for assessing sustainability. It incorporates the three widely reported dimension of performance: social, environmental and economic, and many other studies has reported the three dimensions as the three P's: people, planet and profit (Elkington, 1998; Slaper and Hall, 2011; Alhaddi, 2015).

2.1.1 Environmental dimension of TBL

Matters pertaining to environmental aspect are reported as the protection and conservation of biodiversity and the environment, through reduction of waste, prevention of pollution such as greenhouse gas emissions, and efficient usage of natural recourses (Alkhaddar et al., 2012). This is the *planet* section of the TBL. Generally, it requests for engaging in practice that does not compromise the environment for generations to come, by minimising ecological footprint improving an organisation's sustainability. Assessment of environmental bottom line is not restricted to any single entity but spans across various businesses, and challenges behaviour across the board. Alhaddi (2015) revealed that a study conducted to assess possible financial advantages among organisations with practices that support protection of our environment against organisations without such practices, result in favour of the former. Such financial advantage is generated from reduction in operational costs (energy, water and fuel usage).

2.1.2 Social dimension of TBL

The social aspect has been reported to be the least sought-after dimension, and is often sidelined in literature (Heravi et al., 2015). It refers to *people* aspect of the TBL and aims to assess the impact of organisations on its stakeholders, based on the organisations' action to community relations, staff training, women's right, wages and working conditions (Elkington, 1998). Alhaddi (2015) further emphasise the social aspect of TBL as creating value for the community by "giving back", through fair wages or provision of health care coverage for their employees, which is seen in some organisations today.

2.1.3 Economic dimension of TBL

Profits, returns on investments (ROI) and other economic values generated by organisations are the main concerns to the economic bottom line. It refers to the *profit* aspect of TBL generated through producing products and providing services for customers, for a price. This is a common practice among most organisations nowadays.

Currently, large number of articles (Lemonick, 2009) reported the focus on environmental dimension through the lens of sustainability, thereby viewing the economic and mostly the social dimension at a peripheral lens (Heravi et al., 2015). But as time goes by and the knowledge of sustainable development circulates, and there is a common agreement that measuring sustainability success requires the amalgamation of TBL and assessing the balance among them (Opoku and Ahmed, 2013). Furthermore, the discussion of the TBL concept presents a controversial issue, where questions on whether the framework is quantifiable or justifiable, and if it should be seen as integral to all aspects, action and decisions made were addressed. From one perspective, TBL was traditionally about economic benefits, and has been often been reported as the only bottom line that applies to measuring organisations' sustainability (Slaper and Hall, 2011). Norman and MacDonald (2004) exclaimed that TBL is envisioned as the best marker for measuring corporation's success and assessing how sustainable the business really is, which is widely accepted by its supporters.

From another perspective, TBL lacks a certified measuring system (Slaper and Hall, 2011), as the three separate accounts cannot be easily summed up. Therefore, works by Norman and MacDonald (2004) and Voinov (2007) offered harsh critique by challenging the notion of the ambiguity surrounding the measurement parameters of the TBL, and the underlying fact that it misleads its supporters. Alhaddi (2015) dealt a subtle criticism to TBL based on the interchangeable usage of TBL and sustainability, but highlights that even though the terms are similar in nature, they are not the same and that authors should be explicit when reporting either terms.

2.2 Sustainability in Construction industry - Sustainable construction

As this report is aimed to explore the environmental and social impact of sustainability in the construction industry or project, a background on the sector is as follows. There are reports informing that construction industry demanding high energy and producing tonnes of waste (sometimes hazardous ones) are not rare in literature (Heravi et al., 2015). As so, the industry consumes considerable amount of money due to costs associated to project/building execution, procurement of building materials, maintenance and demolition. However, the industry helps in satisfying the basic social and physical needs through the provision of infrastructures, accommodations and consumer goods, and in doing so, stimulates and generates significant economic returns (Durdyev et al., 2018). In contrast, the industry has a detrimental effect on the environment in terms of land use, water usage, resource usage such as materials and timber consumption, and greenhouse gas emission, (Opoku and Ahmed, 2013; Durdyev et al., 2018).

As a result, the need for sustainable construction practice has been requested by scholars, with suggested approach such as the one reported by Opoku and Ahmed (2013): *"Construction that brings about the required performance with the least unfavourable ecological impacts while encouraging economic, social and cultural improvement at local, regional and global level"*.

The sustainable construction (SC) concept was reported by Fernandez-Sanchez & Rodriguez-Lopez (2010) as being tactically developed to be centred specifically on buildings, but has been adopted through the civil engineering sector. Khalfan (2006) defined sustainable construction as a process carried out with the incorporation of the TBL in order to deliver a sustainable outcome, encompassing an environmental responsibility, social awareness, and economic profitability to the wider environment. Durdyev et al. (2018) who reported the term as, a holistic and integrated perception, which harmonises and creates a balance between the environment, economy and society further supported this. Some authors reported SC without thorough emphasis on TBL by mainly looking at the concept through the lens of environmental dimension. For example, the development of a healthily built environment that considers the efficient use of natural resources, the design of buildings that will allow energy savings, protecting the health of residents and ensuring their well-being (Dobrovolskiene and Tamosiuniene, 2016). In general, sustainable construction incorporates the subject of sustainable development as it

aims to reduce a building's environmental impact, ensure occupant's comfort and safety throughout their residence term, and simultaneously enhance its economic value (Opoku and Ahmed, 2013).

Some previous sustainable construction studies have observed that the environmental dimension of sustainability gained its highest attention within the construction industry (Edum-Fotwe & Price, 2009). Environmental dimension of sustainable construction is concerned with the management of the physical and natural resources and ensuring their conservation for the future (Renukappa et al., 2012). Thus, literatures have requested for efficient use of natural resources by the construction industry. Dyllick and Hockerts (2002) reported that only when organisations strive to consume natural resources below the reproduction rate, cause emission at a rate below that which the natural system can absorb, disengage in activities that degrade, the eco-system services, then it can be deemed environmentally sustainable.

Retrospectively, the shift from addressing sustainability from the environmental and economic point of view to a social-economic view, was reported. Edum-Fotwe & Price (2009) explored the social dimension of sustainable development within the built environment and put forward a framework to articulate the social issues in combination with the environmental and economic issues.

2.3.1 General reported challenges of sustainability

An effective implementation of sustainable construction was reported to be one that covers all aspects of the TBL in a uniform manner (Sev, 2009). However, according to Renukappa et al. (2012), industries lack a collaborative definition of sustainability and its objectives throughout the supply-chain, expressing difficulty in understanding and implementing the initiatives. This was reported to be common with construction firms, resulting to lack of common and operationalised understanding on the general concept of sustainability.

Sustainability practice within the construction industry has a high complexity of execution. Hoffman and Henn (2008) conducted a series of analyses on the barriers to sustainable construction and green building. Social and psychological barriers that incur between an individual, organisational and institutional level were reported to exist inter-connectedly, whereby on an individual level, the decision makers cognitive decisions are influenced by over-discounting the future, positive illusions, assumption of a fixed-pie bias and environmental literacy. Activities at an organisational level are influenced by the internal culture and interaction, language, rewards, and organisational inertial, which was reported to shape the multifaceted problem of adoption of sustainability (Hoffman & Henn, 2008). Defined boundaries and responsibilities, as well as competing interests, see the assumption of a fixed-pie, which facilitates a decision to ignore the implementation of sustainable construction practice and as a result, prevents an organisation from potential accompanying benefits. Likewise, organisations do not like change due to the fear of the unknown, and people prefer habitual routines and an organisational structure that has been developed and seen as successful historically, even though it might not be sustainable in the long-term (Hoffman & Henn, 2008).

From the lens of Institutional Theory, research showed that three categories influence the adoption of sustainable construction, namely; regulative, normative and cognitive aspects. Regulative (or legal) institutions, seen as authoritative bodies which sanctions businesses to 'be sustainable', and as a result, excluding innovativeness and societal interest behind.

Normative (or social) institutions, expressed a 'business rule of thumb' and occupation standards, whereby standard setting bodies strain the implementation of sustainability. Reports from Hoffman & Henn (2008) show that the construction industry encompasses various organisations and have specific parameters on which a building must be constructed, along with training procedures for future professionals.

The cognitive institution presents the perceptions that are powerful, and resistant to change, which strongly influence individuals and organisations indirectly. Due to the complexity of sustainability as a concept, decision makers in the construction industry encounter various challenges and barriers. Among these is the lack of awareness, and effective approach to a sustainable development (Garbie, 2015). That is, when, where, and how should sustainability be implemented into practices and still withhold its competitive advantage?

Methodology

3.1 Systematic Literature review

A systematic review of the relevant literature referring to UK construction industry is the selected approach to answering the study's research question. The required information included a series of peer-reviewed journal articles and related

reports. This covered the aspects that contextualise sustainability in the construction industry, with great emphasis on the environmental and social dimension of the triple bottom line. Other relevant literature focusing on the impacts of construction managers and other decision makers on sustainable construction practice in the UK were sought for.

3.1.1 The search strategy

The reporting process of the systematic literature review adhere to the principles proposed by Boland et al. (2017). Scoping searches were conducted to gain an overview on the availability of published literature which relates to the research question. The University of Liverpool (UoL) digital library database was used to conduct the scoping searches. This was due to its abundance of multidisciplinary journal articles, books, case studies, magazines, conference materials and many more.

The main literature searches were accomplished through searches based on journal articles focusing on sustainability concepts. Through this, the selection of database was conducted. A general google search for "what databases is most suited for social science research" returned an article by Oppenheim (2008), which stated that Web of Science and Scopus have the best social science coverage at journal level. Therefore, the two were the selected bibliographic databases. The UoL library offered an integrated search engine, therefore, the scoping searches were conducted using UoL's search engine only.

3.1.2 Inclusion and exclusion criteria

Studies included if they:

Are published in English and within 1995 to 2018

Report information about sustainable construction in UK industries only

Publish data that shows a measurement of sustainability in the UK construction industry

Include the drivers and/or challenges of a sustainable practice in UK construction

Focus on UK green building or construction

Studies excluded if:

They are published prior to 1995 - (The inception period of the sustainable construction guidelines).

They are not published in English

The sourced data are not based on the UK construction industry

Data not relatable to research topic based on the abstract section, or fails to address elements of the research question

Do not address the Triple Bottom Line framework

The search was conducted under the field of "article title, abstract and keywords", with limits including article published date between 1995 to 2018. All types of documents were allowed for a more definitive search return.

Table 1: Data search syntax

Databases	Search syntax
Web of Science Scopus	TITLE-ABS-KEY ((Sustainability OR "sustainab* practice*" OR "sustainab* develop*" OR "triple bottom line") AND (("construct* industr*" OR "construct* project*") OR ("sustainab* construct*" OR "sustainab* buil*" OR "green construct*" OR "green buil*")) AND ("UK" OR "United Kingdom" OR "Brit*")) AND PUBYEAR > 1994.

The criteria shown in table 1 were applied in a systematic, step-by-step process, where additional choices were provided by the search engine in terms of full text availability and limitation of subjects searched. The search returned on both databases were exported to an excel file where they were screened and assessed for eligibility for inclusion using the PRISMA flow diagram process proposed by Moher et al. (2009). The PRISMA flow chart is presented in figure 1.

3.1.3 Content analysis

According to Elo and Kyngas (2008), content analysis is suitable for qualitative and quantitative data, which can be analysed in an inductive or a deductive way.

Inductive analysis

During the systematic literature review, an inductive content analysis was used to identify the concepts of literature in the field of sustainability and sustainable construction. The process involved collecting relevant data on the subject field, and comparing and contrasting the obtained data in an attempt to gain a clear overview of the concept.

According to Bengtsson (2016), the researcher analyses the obtained data with an open mind to seek out related subject that addresses the aim of the subject in an attempt to allow a generation of meaningful conclusion. This process includes de-contextualisation, re contextualisation, categorising and compilation of data obtained. This was the process used for the synthesis of the systematic literature review in this research.

De-contextualising

Due to the rising prominence of sustainability practices, vast number of articles were returned from the search criteria. To efficiently exclude irrelevant articles, the de-contextualisation process was used. This was carried out by reading through the title and the abstract section of the selected papers, gaining an overview of what the research is addressing. This process is noted to be an efficient and timesaving practice. Relevant information was recorded in a spreadsheet to be reviewed at a much deeper length.

Re-contextualising

The process entails gathering all relevant articles collected through the aforementioned stage. During this research, a colour coding scheme was implemented, where studies of sustainable *practice*, *operations*, and *perception* were allocated individual colours.

Categorising and data compilation

After the completion of the previous process, a compilation of relevant data was compared for suitability with the aim of the research study.

Deductive analysis

Due to the strict nature of the inclusion criteria, a deductive process was implemented to narrow down relevance of papers to the project aim. Elo & Kyngas (2008) reported that deductive analysis is based on the structures, concepts or theories which are already known with the study. For instance, in this research, environmental and social dimension of a sustainable construction, CSR, assessment criteria and perceptions were used as restrictions for assessing the impact of sustainability in UK construction industry.

3.1.4 Validity and trustworthiness

Transparency has been provided on the method of which articles were obtained for the research purpose. Bengtsson (2016) mentioned that the content analysis process is mostly judged by the process undertaken whilst retrieving articles. Thus, with guidance from the literature presented by Elo & Kyngas (2008), the results obtained from the data collection process is repeatable and can be deemed reliable.

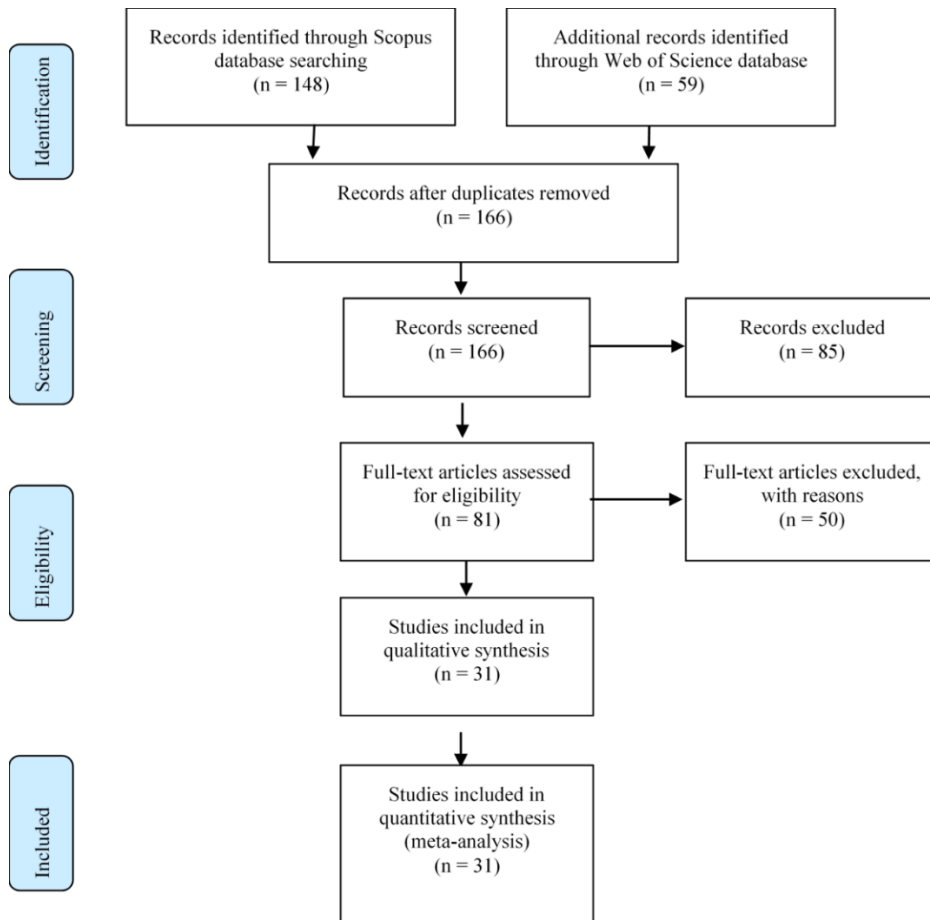


Figure 1: The PRISMA flow diagram

Findings

This section contains the presentation of the results compilation of the selected articles. The execution of searches was through the use of two widely known databases for social science studies. Scopus and Web of Science were the databased used which returned a total number of 80 relevant articles, conference papers and reviews on the topic of sustainability in the construction industry. As the focal point of this research was based on sustainability in the UK construction industries, the guidance used during search was focused on studies relating to sustainable construction in UK construction industries. Since sustainability and sustainable development became noteworthy in the UK construction industry in the early 1990's, the search result from both databased revealed the earlier published paper to be in year 1996. This has then gained a lot of promises as a rise in number of annually published papers was seen in figure 2.

After a review of the abstracts of each paper, 81 papers were gathered to be construction related. However, after a full text review, the papers obtained was significantly reduced to a total of 31 papers. Due to the nature of the research, a limited timescale offered the implementation of strict inclusion criteria, which resulted to the use of research studies focusing on practices and operations in the UK construction industry only. This result suggests that not only has sustainability issue been growing in construction settings, it is also widely accepted across geographies.

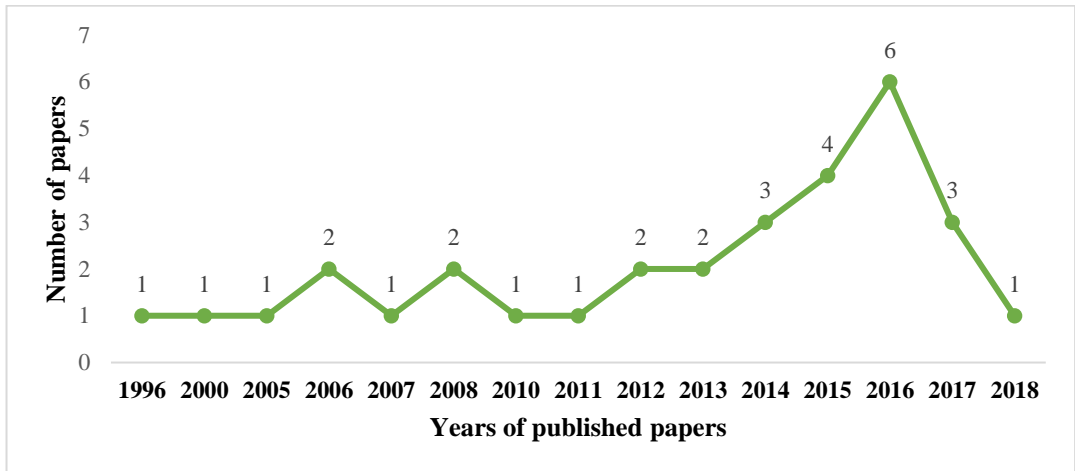


Figure 2: The distribution of papers published

The included papers for the systematic literature review are covered in 22 different journals in which were categorised in construction, engineering, manufacturing, business, energy, sustainability and geographical related journals. The dominating field of study was the guidelines and assessment criteria of sustainable construction practices and a common referral to the aspect of triple bottom line in construction projects.

Concerning the location of the sourced data used in the papers reviewed, the umbrella covered a global scale. However, the research question demanded an utilisation of UK focused articles only. Table 2 presents the results of the review, listing the thirty-one returned articles.

Results and Discussion

The majority of the articles collected (75%) addressed the development or delivery aspect of sustainable construction, whilst the remainder (25%) glanced at the certification and energy assessment in UK construction projects.

Environmentally, authors reported the need for green buildings practices, assessment criteria and knowledge/awareness enhancement in the construction sector. Likewise, actions such as integration of sustainability to the core of business practice is revealed.

Legislation, customer requirements, corporate image and reputation enhancement, optimisation, waste elimination, financial institution, personal motivation and top management commitment were the commonly reported drivers for adopting sustainable practice in the construction industry (Akadiri & Fadiya, 2013; Ogunbiyi et al., 2014; Wang et al., 2014; Murtagh et al., 2016).

However, Darko et al. (2017) amalgamated and categorised the key drivers under the following categories:

- external drivers
- corporate drivers
- property-based drivers
- project-based drivers
- individual drivers

Information obtained from Shan et al. (2017), Opoku & Ahmed (2014), Petri et al. (2015), Murtagh et al. (2016), and Hopkins (2016) revealed the common barriers/challenges frequently reported in literature to include:

- lack of consistency in general practice
- lack of sustainability knowledge/awareness to best practice
- high upfront cost
- lack of stakeholder consideration

- lack of resources such as sustainability assessment software
- lack of incentive

5.1 How wide is sustainable issue being addressed in UK construction industries?

The essence of addressing sustainable issue in UK construction sector was to develop an understanding on the actions, practices, methods, tools and techniques and knowledge of sustainability in industries. A widespread approach to sustainable issues in the UK construction industry revealed by numerous authors listed in table 2.1, suggested that the topic is well studied. Approach towards examining the environmental and social concerns of conventional construction activities proposed a huge interest of the topic to academic researchers and practitioners. Interests ranged from identifying and reporting the importance of sustainable construction practice through journal articles, conference papers, short reviews, meetings and proceedings, with the attempt to increasing awareness of the sustainability issues among practitioners along construction supply chain (Higham & Thomson, 2015; Hopkins, 2016). Raising awareness of the issue is of outmost importance because it provides a benchmark for all parties involved. For example, the data obtained from interviews conducted revealed a scattered opinion about the topic, therefore, a valid explanation for that would be a lack of common understanding of the concept and this point is supported by other authors; (Petri et al., 2015; Opoku & Ahmed, 2014; Higham & Thomson, 2015; Hopkins, 2016).

Furthermore, the sustainability of a building was mentioned to address only the operational life at the inception of the building project (Berardi, 2013). Since 70% of the resources extracted ends up in the buildings, researchers and practitioners found that it is essential to increase awareness for sustainable construction practice and an evaluation approach of cradle-to-cradle and end-of-life in order to prevent catastrophic events such as unavailability of building material for future generations. As a result, Higham & Thomson (2015) presented a discourse, stating that a shift in mind-set on the approach to sustainability concept is essential.

Table 2: A summary of the articles gathered using a systematic review

Author(s) (year)	Title	Overview	Key reasons for inclusion
Xia <i>et al.</i> (2018)	Conceptualising the state of the art of corporate social responsibility (CSR) in the construction industry and its nexus to sustainable development.	A review of CSR context to construction industry was carried out through systematic reviews of current literature.	The study contributes to social aspect of sustainability, which is related to the research topic.
Darko <i>et al.</i> (2017)	Drivers for green building: A review of empirical studies	A literature review of drivers of green building was explored based on leading countries involved in green building.	An empirical analysis that presented the findings of previous studies. This can be utilised for comparison with other related literature.
Doan <i>et al.</i> (2017)	A critical comparison of green building rating systems	A systematic review of current articles comparing sustainability assessment methods such as LEED, BREEAM, CASBEE and other green rating system.	Article is related to research topic. It provides discussion points for answering questions related to sustainable practices in construction operations.
Shan <i>et al.</i> (2017)	A global review of sustainable construction project financing: Policies, practices, and research efforts	A systematic review of sustainable construction project financing. Focal point about financing construction projects.	Article is supporting the research topic. It provides discussion points for answering questions related to the perceived drivers/challenges of sustainable construction.

Brooks & Rich (2016)	Sustainable construction and socio-technical transitions in London's mega-projects	A study that explores how sustainable procurement is deployed in the construction industry as well as identifying barriers to sustainable procurement of materials - cost and risk	Article provides an insight to green practice such as sustainable procurement of construction materials. The views of procurement professionals and decision makers on construction projects were reported.
Darko & Chan (2016)	Critical analysis of green building research trend in construction journals	An overview of green building trends in terms of number of publications, geographical contributions and topics covered.	The study focuses on articles for green building from 1990 to 2015. This improves the research systematic review efficiency.
Higham <i>et al.</i> (2016)	Sustainability and investment appraisal for housing regeneration projects	Use of assessment framework to evaluate UK sustainable construction practice through quantitative approach.	The research provides points of arguments regarding the dimensions of which sustainability is been assessed in the UK construction setting.
Gottsche <i>et al.</i> (2016)	Assessing the impact of energy management initiatives on the energy usage during the construction phase of an educational building project in Ireland.	A study reporting energy reduction practices in UK building projects, resulting to savings in costs, improvement in resource efficiency, and reduction in environmental impacts.	Article addressed positive outcomes of TBL dimensions as a result of sustainable practice (energy tracking) in UK construction industry.
Murtagh <i>et al.</i> (2016)	The relationship between motivations of architectural designers and environmentally sustainable construction design	Psychological factors such as motivation, awareness of work's impact on others and so on, were identified as a driver for contributing to sustainable practice in construction industry.	Some of the major social drivers of sustainable practice in UK construction industries were revealed.
Hopkins (2016)	Barriers to adoption of campus green building policies	Environmental impacts derived from lack of sustainable adoption were presented in the article. The common challenges faced were reported by the author and possible solutions were offered. Research explores the awareness and sustainability literacy of construction professionals at both theoretical and practical level.	The article addresses the environmental dimension of the TBL, which is critical to the research topic.
Higham & Thomson, (2015)	An evaluation of construction professional's sustainability literacy in North West England	Findings showed correlation of strong awareness at theoretical level and weak knowledge at practical level due to high interpretation of sustainability concept.	Research provides answers to the challenges faced by construction decision makers.
Petri <i>et al.</i> (2015)	A semantic service-oriented platform for energy efficient buildings	The research introduces a service-oriented platform that integrates access to sustainability resources to address the lack of awareness and positive energy practice. It educates and encourages building managers to implement energy efficient optimisation plans by engaging construction stakeholders with sustainability practices	Relatable to research question by revealing opportunity for addressing barriers of sustainability practices in construction industry.
Dadhich <i>et al.</i> (2015)	Developing sustainable supply chains in the UK construction industry: A case study	Research looked into identifying emission 'hotspots' across the lifecycle of a plasterboard supply chain	Supply chain accounts for part of the lifecycle in construction project. The article revealed the depth of sustainability practices in UK construction projects.

Wang <i>et al.</i> (2014)	Use of wood in green building: A study of expert perspectives from the UK	Article exploring the use of green construction materials such as wood as a means of sustainable practice. Result showed that due to levels of sustainability education among stakeholders, there are varied acceptance to the proposed concept.	Discusses the drivers of sustainable construction, specifically green buildings, and promotes wood as a solution for achieving greater sustainability results.
Opoku & Ahmed (2014)	Embracing sustainability practices in UK construction organizations: Challenges facing intra-organizational leadership	Research on challenges faced by leaders in construction industry when adopting sustainable practices	Emphasis on the challenges faced by construction managers and decision makers on implementing sustainable construction practice was explored.
Ogunbiyi <i>et al.</i> (2014)	An empirical study of the impact of lean construction techniques on sustainable construction in the UK	A research addressing the impact of lean construction technique revealed positive effect to TBL dimension of sustainability	The TBL dimension were addressed, and the study revealed various benefits as a result of sustainable practice implementation.
Akadiri & Fadiya (2013)	Empirical analysis of the determinants of environmentally sustainable practices in the UK construction industry	Determinant of environmentally sustainable practice in UK construction industry were revealed to include top management commitment, government regulations and construction stakeholder pressures.	The article provides information on the drivers of sustainable practice in construction settings.
Florez <i>et al.</i> (2013)	Measuring sustainability perceptions of construction materials	Sustainable construction materials were identified as a means for decreasing the negative impact on the environment. Different views were examined due to varied opinions on sustainability in general	The article enhances the perceptions of decision makers on construction materials, addressing the environmental, social and economic benefit to the construction industry.
Akadiri & Olomolaiye (2012)	Development of sustainable assessment criteria for building materials selection	Selection of sustainable building material can be difficult due to ambiguity amongst construction professionals. Assessment criteria, along with methods and processes to execute the assessment was explored.	The article reported challenges to sustainability practice in the construction industry.
Renukappa <i>et al.</i> (2012)	A critical reflection on sustainability within the UK industrial sectors	A research exploring the perception in multiple industrial sectors (construction industry included) on the concept of sustainability. Findings included variability in perceptions at different industries. Most importantly, the proposed solution included an industry wide awareness-raising programme.	The article provided a glimpse of sustainability drivers/challenges perceived in related organisations, including the construction industry.
Rodriguez-Melo & Mansouri (2011)	Stakeholder engagement: Defining strategic advantage for sustainable construction	A study depicting the relationship between stakeholder engagement and a prosperous sustainable practice. This was perceived as both a driving factor and hindrance to sustainable practice in UK construction industries.	An insight to stakeholder behaviour was revealed.

Essex & Whelan (2010)	Increasing local reuse of building materials	Reuse of surplus construction product creates opportunities of employment and training in new skills.	Based on social benefit of sustainability.
Ravetz (2008)	Resource flow analysis for sustainable construction: Metrics for an integrated supply chain approach	Sustainability metrics and benchmarks are used in determining sustainability impact across the construction supply chain. The study presented the available metrics in UK construction industry	This study reveals the depth at which sustainability practices are being honoured in the UK construction settings.
Taylor & Wilkie (2008)	Briefing: Sustainable construction through improved information flows	Transparency of construction processes, from design to use, was presented and segments which prevent sustainability practice were identified and explored to recommend potential solutions for future reference.	Research revealed the barriers to sustainable design in the UK.
Bosher <i>et al.</i> (2007)	Realising a resilient and sustainable built environment: Towards a strategic agenda for the United Kingdom.	Research calls for immediate integration among construction stakeholders	Research revealed the barriers to sustainable design in the UK.
Shiers <i>et al.</i> (2006)	Sustainable construction: The development and evaluation of an environmental profiling system for construction products	The article explores why environmental tools are less implemented in construction projects. The findings of the article exclaimed disparities between project specification and practices.	These are potential challenges faced by construction professionals
Hansen & Vanegas (2006)	A guiding vision, road map, and principles for researching and teaching sustainable design and construction	The fundamental area of improving sustainability awareness was revealed as through educating the mass about sustainability throughout construction supply chain.	This article shows the depth consideration for sustainable practice in UK construction settings.
Myers (2005)	A review of construction companies' attitudes to sustainability	Research explores the perception of construction organisations towards sustainability practice	Reviews attitudes to sustainability and corporate social responsibility of construction companies listed in the stock exchange market.
Bartlett & Howard (2000)	Informing the decision makers on the cost and value of green building	The article explored the potential payback value of a green building.	The economic dimension of the TBL is explored
Raynsford (1999)	The UK's approach to sustainable development in construction	Emphasis of UK's approach to sustainable construction during the late 1990s was revealed.	Findings from the article contribute to discussion about shift from previous practice to current perceived practice in the construction settings.
Pitts (1996)	Teaching renewable energy and the sustainable building network	Emphasis on the impact of educating current generation about sustainable building networks is promoted in the article.	Article revealed that sustainability awareness has always been a challenge in the construction industry. Therefore, constant drive to improve awareness is a discussion topic.

5.1.1 Environmentally sustainable construction

The literature suggested that the main agenda of the UK construction industry is to contribute to the reduction of greenhouse gas emission (Essex & Whelan 2010). Actions, such as the use of sustainable materials, were explored by Florez *et al.* (2013) and Wang *et al.* (2014), reporting that the strategic use of construction materials can be achieved through the reuse and recycling process, and it serves as a means of reducing construction waste generated on building projects. Thus,

reducing cumulative landfill waste, which as a result, produces very little impact on the environment through the building lifecycle and concomitantly, reduces carbon emission.

Furthermore, actions including the integration of lean construction practice were reported by Ogunbiyi *et al.* (2014) as another issue addressed under sustainable construction practice, revealing the various benefits. Construction waste generated, and other environmental impacts are reduced, social benefits are gained through value generation, increased productivity is observed, increased health and safety, and an encouraging working environment is created due to implementation of lean construction practice. This finding were similar to that of Taylor and Wilkie's (2008) report, which revealed additional benefits including improved information flow which reduces construction risks, maintenance of future value, and reduction of operation costs.

Energy management initiatives practice in UK construction were reported by Gottsche *et al.* (2016), who disclosed the opportunities, including reduction in CO₂ emitted from electricity usage, through effective site management practice. Once again, use of technology facilitated the reported sustainable opportunity. Research by Shan *et al.* (2017) on sustainable project financing showed that sustainable development is being promoted at a fast rate due to investments from banks and other governmental schemes. The world's first green investment bank was set up by UK in 2012, with the attempt to support investment of green/sustainable projects (Shan *et al.*, 2017). Sustainable building rating assessment/rating system including the renowned UK's very own Building Research Establishment Environmental Assessment Method (BREEAM) and Leadership in Energy and Environmental Design (LEED) (Potbhare *et al.* 2009 and Doan *et al.* 2017) were frequently distinguished in the literature as method of assessing sustainability in UK construction industry.

5.1.2 Socially sustainable construction

The theory of how the environment influences organisations and how organisations affect each other has been in development over a long period of time, thus, the relationship between business and the social environment is an essential topic of discussion. The demonstration of social responsibilities by UK construction industry has not been widely reported through the findings of the systematic review, but it is a growing phenomenon amongst practitioners (Edum-Fotwe & Price 2009). Xia *et al.* (2017) in their study revealed that corporate social responsibility (CSR) is gaining more attention as a method to be engraved in sustainable construction activities throughout construction projects. The author reported the social concerns of construction activities to workers health and safety. Due to the competitive and labour-intensive nature of the job, exposure to accidents is high and there are possibilities of operating under unsafe and unhealthy conditions. However, CSR, through the discourse in areas of public health, public controversies, skills and education, social justice, working conditions, human right, workplace safety and equal opportunity, mitigates the stated concerns as construction organisation are required to display a legal, ethical and discretionary expectation with stakeholders involved in the project (Xia *et al.* 2017; Renukappa *et al.*, 2012).

Conclusions

The obtained results revealed that many sustainability practices are fully operational in UK construction industry and are actively implemented into practices. The UK construction industry has demonstrated that it can improve on its sustainability activities at every level due to present actions driving the concept. Availability of technology for sustainability assessment, increased transparency of the concept among stakeholders and the perceived accompanying benefits to the UK construction industry are part of the drivers.

However, the environmental dimension of sustainable construction has seen more attention in comparison to the social dimension as there are assessment tools and criteria available. For instance, BREEAM or LEED, which are useful for measuring energy usage and emitted greenhouse gas and overall building sustainability during and after construction projects, whereas, there are no reports of similar tools found from literature, to provide consistently gauge of social sustainability practices during activities. Therefore, efforts to develop such methods for measuring social sustainability is stressed. Likewise, a significant challenge reported in literature, framing lack of sustainability awareness as the key drawback must be addressed as this serves as the foundation for any sustainable activity, pertaining to the construction sector or not.

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